B. OVERVIEW

This appendix describes the hazards that may pose a threat to the public or the environment from Sea Launch operations. Hazards that Sea Launch systems or operating personnel may encounter that do not pose a threat to the public or the environment are not discussed. The following subsections are included: B.1 Home Port Assessment, B.2 Launch Site Assessment, B.3 Characteristics of Hazardous Materials, B.4 Hazardous Waste, B.5 General Industrial Waste, and B.6 List of Hazardous Materials.

The proposed Sea Launch Home Port is an industrial operation common with other daily industrial and commercial activities at the Port of Long Beach located in the Los Angeles area. The Port and City of Long Beach and State of California are highly experienced in regulating varied businesses, many of which are inherently much more hazardous than Sea Launch. Oversight will be provided by the local regulatory agencies responsible for ensuring safety at the Home Port.

The facilities at the Home Port have been specifically designed to minimize the potential for any accidents, and in the rare event of an accident, to minimize the potential impacts. It should be noted that there are no public areas on the Navy Mole. The open space located to the east of the Home Port is being used for the relocation of trees from the Navy Shipyard, supporting the Port of Long Beach in its efforts to obtain air quality credits. The Port of Long Beach has no plans to allow public access to this area. Industrial facilities do not currently operate on the Navy Mole. The Port of Long Beach intends to lease the adjoining property for use as a container storage area, which would be similar to the other container storage facilities in the Port of Long Beach.

Risks due to hazardous material spills, explosions, or other catastrophic events will be minimized by the design of the facilities and the required plans and permits for the operation of the Home Port. The facilities have been designed to meet several criteria. The Codes that were followed include: Uniform Building Code, Uniform Fire Code, National Electric Code, DOD Ammunition and Explosives Safety Standards, and CPIA guidance. In addition to meeting a variety of design criteria, operation of the Home Port will not occur until Sea Launch has prepared numerous plans which are required by Federal, state, and local regulations. These include, but are not limited to: Chemical Import Certification, Hazardous Materials Emergency Plan, Spill Prevention Control and Countermeasure Plan, Facility Response Plan, Operations Manual, Stormwater Pollution Prevention Plan, and Hazardous Materials/Dangerous Cargoes permit.

Under these plans, Sea Launch will develop designs (e.g., dikes, berms) to contain spills of petroleum and will outline responsibilities and perhaps conduct simulations to respond to catastrophic hazardous material or other events. Sea Launch will actively work with local emergency organizations (e.g., fire and police departments) to ensure these preparedness and response plans are based in reality. Sea Launch has the benefit of designing the facility with safety in mind. Safety distance requirements for storage and handling of propellants were determined to be adequate to protect inhabited buildings and public traffic routes (Department of the Navy, 1996). Employees will be informed of work hazards and trained to follow proper operating procedures and to respond to anomalies. Response to spills into the port or navigable waterways and other environmental areas will be coordinated logistically and procedurally with Coast Guard and other proper authorities.

Although the results of a potential accident could be substantial, between the design of the facility and the plans and procedures that are required to be in place by regulations, it is anticipated that any impacts to public safety and the environment would be minor and mitigatable.

Specialized facilities and equipment are being designed and will be constructed for the dedicated purpose of Sea Launch Home Port operations. A primary objective of the design and construction will be to ensure safety of not only Sea Launch employees, customers, and extremely high value equipment, but to safeguard the public, property, and the environment.

Sea Launch will provide new seagoing vessels which will be used to perform the final steps in the rocket assembly process. These vessels will contain unique features which will enable Sea Launch personnel to support launch vehicle assembly operations and ensure safe operations. Local port regulations, national and international maritime regulations, and design standards will be adhered to in the design of the vessels and in the operations carried out onboard.

Sea Launch will provide a working marine facility where provisioning, storage, and fueling will be performed in support of the maritime operations. Existing buildings, the pier, driveways, and utilities will be upgraded for the dedicated functions performed on the vessels and through the use of its support equipment. Operations will be comparable to other marine terminal and industrial facility activities currently being performed in the port area.

Sea Launch will conduct a thorough and formal safety analysis of designs and operations prior to the start of testing or to the start of normal operations. This effort will be led by Boeing Commercial Space Company (BCSC) personnel, who have gained a high level of experience in the safety analysis process from years of work in the defense and aerospace industries. The BCSC's policies emphasize safety and environmental protection in all operations for commercial, non-commercial, and internal ventures. Sea Launch management stresses safety and environmental protection as a key issue throughout the program planning and development phases. The development structure used within Boeing and carried over to Sea Launch is to build in safety by identifying and mitigating potential hazards early in the preliminary design phase.

This safety analysis approach has several important benefits to Sea Launch:

1. Economy in lower rework costs and lower costs due to liabilities.
2. Efficiency due to improved delivery response and fewest interruptions.
3. Protection for employees, the public, public property, Sea Launch assets and investments, and the environment.
4. Prevention of fines and stop work orders by ensuring compliance with applicable regulations.

The Home Port will be located on the converted Long Beach Naval Base breakwater known as the "Mole." The property will be owned by the Port of Long Beach which has controls in place to limit public access. The facilities surrounding the Home Port consist of container cargo terminals, heavy industrial manufacturing plants, shipyards, oil drilling, and other comparable industrial and maritime activities. Considerable distances separate the Home Port property from non-industrial activities. The Queen Mary (the nearest tourist attraction) is 2.4 km away. The Interstate 710 freeway area is a major traffic artery feeding the port area and is over 1.6 km away at its closest point. Nearest urban development containing small businesses, residences, and major shopping centers is 3.2 km to 6.4 km away.

Home Port operations will mainly consist of the receipt, processing, and transferring of payload elements at the land-based facilities, and the receipt, processing, and transferring of rocket elements onboard the vessels at the pier. A new perimeter security fence will fully enclose and control access to Sea Launch property. The final spacecraft assembly, checkout, fueling, and encapsulation will take place in the newly constructed PPF located inside a separate perimeter fence. The PFF provides a completely controlled environment for critical operations. The existing pier will be upgraded to provide moorage and utilities for the Sea Launch vessels. The basic structure of the pier will not be modified. A landing will be constructed to interface with the ACS stern ramp for Ro-Ro of cargo and rocket components.

Maritime operations will include pier side loading of supplies and equipment, vessel fueling (which will not occur at the Home Port), and transit between the Home Port and the launch location. At the launch location, the LP will be ballasted to a deeper draft to gain greater stability. The process of ballasting is not unique to Sea Launch and will present no hazard. The transfer of the launch vehicle on the vessels and movement of propellant from storage tanks to the launch vehicle requires appropriate shifting of water ballast to maintain the required vessel pitch and trim. Fueling of the launch vehicle will be accomplished after all personnel have been evacuated from the launch platform. The fueling system will be designed to preclude the release of RP-1 fuel (kerosene) into the environment during normal operations. The launch vehicle will be defueled in the event of a launch abort. During an abort after first stage engine ignition, approximately 70 kg of RP-1 would be lost from the fuel lines (Section 4.3.1). The propellant fueling system will be designed to retain all of the RP-1 fuel during the launch vehicle de-tanking operation. There will be some loss of oxygen due to boil-off during the tanking and de-tanking operations, but this loss will have no environmental impact or safety implications. Liquid nitrogen will be used to condition the fueling system and is converted to gaseous nitrogen to purge fueling system of vapors prior to disconnect of fueling fittings. This operation will prevent spillage of propellant components (kerosene and liquid oxygen) when disconnect occurs. During the purging process some kerosene vapors will be released into the environment.

B.1 HOME PORT ASSESSMENT

The detailed operations performed at the Home Port are summarized as follows:

1. The operations will begin with several warehouse and terminal type activities.

   a) Delivery of spacecraft and ground support equipment (GSE).

   b) Delivery of rocket stages.

   c) Delivery of flammable liquids.

   d) Delivery of compressed gases.

2. The use of crane and materials handling operations to place components in storage or processing as appropriate.

   a) Use of cranes to move payload and rocket elements in PPF and ACS.

   b) Use of dollies and trolleys to move rocket and fairing elements in warehouse.

   c) Use of transport vehicles to move encapsulated payload between buildings and vessels.

   d) Use of handling fixtures and stands to align and mate launch vehicle elements during final assembly.

3. Assembly and test steps involve systems checkout, final installations, and pressure tests of spacecraft and stages.

4. Cargo handling, terminal and bulk plant type operations, transfer components between vessels, and land facilities.

    a) Loading of flammable liquids and compressed gases from trucks to vessel tanks.

    b) Transfer of integrated launch vehicle from ACS to LP.

    c) Crane lifting of fairing containers from barge to pier or from truck to transport dolly.

5. Warehousing and shipping operations will involve unpacking and uncrating, receipt of maintenance supplies, materials storage, fairing container handling, and forklift and hoist operating.

B.1.1 Preliminary Hazard Analysis of Home Port Land-Based Operations

Preliminary hazard analysis of the Home Port operations began with the development of a list of high-level hazards that are based on materials and equipment involved in the operation. Four areas of concern were also determined for inclusion in the evaluation. They are as follows:

1. Public safety.
2. Sea Launch and customer personnel safety.
3. Damage to equipment or equipment safety.
4. Environmental protection.

The four principal hazards and general tasks identified which may have impacts on the public or the environment are:

1. Handling propellants for spacecraft and upper stage; transport and fueling with MMH, N_2H_4, and N_2O_4.
2. Handling solid rocket motors and pyrotechnic devices; shipping and installation of SRMs, explosive bolts, pin pullers, cable cutters, and pyro-activated valves.
3. Loading launch vehicle gases and fuel on vessels; receipt and transfer of LOX, nitrogen, helium, and kerosene to bulk tanks onboard the LP and ACS.
4. Handling rocket stages and the assembled launch vehicle, crane lifts and wheeled dolly movements of fueled vehicle elements, and crane transfer of the assembled launch vehicle to LP.

In assessing potentially hazardous operations, all of the tasks contained in the operations were evaluated. Those that met the principal hazards criteria were grouped together in related generic operational categories. The categories of tasks identified as potentially hazardous are discussed in the following paragraphs.

It should be noted that all of the operations identified as potentially hazardous will be conducted in Sea Launch facilities which are uniquely designed to support the operation. The Navy "Mole" is designated as Port of Long Beach property, and public access to the location is limited. The Home Port site is fully fenced and patrolled by 24-hour security. Access to areas supporting hazardous operations will be strictly controlled.

B.1.1.1 Payload Processing Facility Operations

Four operations related to the processing of spacecraft at the payload processing facility have been identified as potentially hazardous due to the potential for a hazardous material release and employee exposure during a release. The major hazards involved in these operations are summarized here from detailed information and analyses prepared as part of Home Port permitting and licensing by Federal, state and local government agencies (Port of Long Beach Harbor Development Permit application):

1. Handling of flammable fuels and toxic oxidizers for spacecraft processing.
2. Handling of small pyrotechnics valves, pin pullers, and cable cutters during installation in the spacecraft and fairing.
3. Operating pressurized systems containing high pressure gas or toxic/flammable liquids onboard the spacecraft.
4. Crane handling of fueled spacecraft from the fueling stand, to the dolly, and to the encapsulation stand.

The potential impacts from these operations are:

1. Potential for major impact to Sea Launch and customer property from a very small amount of damage to high value assets and equipment.
2. Potential for major impact from injuries which could occur to Sea Launch and customer employees.
3. Minor impact to public safety or to the environment is anticipated due to the small quantities of hazardous materials present, and because the Home Port's location is relatively isolated from the general public.

The potential for major, adverse impact to Sea Launch employees, customers, and property from these operations is a driving force behind the design of the facilities and equipment described in the introduction of this section (Appendix B). Labor, building design and construction, and environmental regulations at the national, state, and local level must be satisfied before Sea Launch will develop and operate these facilities. Compliance with these regulations will aid in ensuring a safe environment in which to conduct Sea Launch operations, and will provide protection for the public and the environment.

B.1.1.2 Home Port Pier and Storage Facilities Operations

Operations related to materials handling operations at the pier, storage facilities, and throughout the Home Port site have been identified as potentially hazardous. The major hazards involved in these operations are:

1. Transfer of high pressure gasses and cryogenics from trucks to vessel bulk tanks, and the transfer of flammables and combustibles in transportable tanks to vessel storage areas and bulk tanks.
2. Handling of fueled and pressurized spacecraft from the PPF to the ACS via driveways and the stern ramp.
3. Transport of low explosive devices in shipping containers from delivery trucks and vessels to storage facilities and to vessel storage and assembly compartments.

4. The handling of unfueled rocket stages and support equipment via driveways, the stern ramp, and cranes from delivery vessels to storage facilities and to vessel assembly compartments.

The potential impacts from these operations are:

1. Potential for major impact to Sea Launch and customer property from a very small amount of damage to high value assets and equipment.
2. Potential for major impact from injuries which could occur to Sea Launch and vendor employees.
3. Minor impact to public safety or to the environment because of the small quantities of flammables and low explosives present and due to the isolation of the location.

B.1.1.3 Rocket Stages Processing

Major hazards involved in operations related to processing rocket stages and assembling the integrated launch vehicle onboard the ACS have been identified as follows:

1. Handling of combustible fuel, flammable fuel, and toxic oxidizer for upper stage processing.
2. Handling of low explosives devices and pyrotechnic devices during installation on stages.
3. Crane handling and moving rocket stages on wheeled dollies during processing and assembly.
4. Handling of fueled and pressurized spacecraft with the crane and wheeled dolly for alignment and mating to upper stage.

The potential impacts from these operations are:

1. Potential for major impact to Sea Launch and customer property from a very small amount of damage to high value assets and equipment.
2. Potential for major impact from injuries which could occur to Sea Launch employees.
3. Minor impact to public safety or to the environment due to the small quantities of flammables and low explosives present and due to the isolation of the location.

B.1.1.4 Integrated Launch Vehicle Transfer

One operation that has been identified as potentially hazardous is the transfer of the integrated launch vehicle from the ACS to the LP. The major hazard involved in this operation is in the crane handling of the integrated launch vehicle (consisting of the fueled spacecraft, partially fueled Block DM-SL, and unfueled rocket stages with solid rocket retro motors installed) during the transfer from the ACS stern ramp to the LP rocket hangar.

The potential impacts in the areas of concern are:

1. Minor impact to public safety or to the environment due to the small quantities of flammables and low explosives present and due to isolation of the location.

2. Potential for major impact from injuries which could occur to Sea Launch employees.
3. Potential for major impact to Sea Launch and customer property from a very small amount of damage to high value assets and equipment.

B.1.2 Regulatory Agencies and Regulations

The types of potentially hazardous operations (listed above) identify the areas that are being assessed in detail and will receive oversight in facility and equipment development. The regulatory environment in California provides considerable oversight to this development with numerous controls on the Home Port development and operation. Tables B.1.2-1 through B.1.2-3 illustrate the four basic areas of concern (public safety, personnel safety, equipment safety, and environmental protection) and the regulatory focus for the previously identified operations. The table title contains the general description of the type of operations included. The matrix provides a general breakdown of regulatory agencies, and regulations related to each area of concern are shown for three levels of government.

The matrix can be used as a road map to show the application of regulations and agency oversight on identified potential hazards. It also serves as a preliminary "check-off" tool to verify compliance with the laws imposed on the Home Port design and operations.

B.1.2.1 U.S. Coast Guard

Because of the marine nature of the Home Port development, one of the most prominent agencies that Sea Launch will be working with is the U.S. Coast Guard. The U.S. Coast Guard has the charter to enforce the safety and security of ports and to enforce laws relating to the protection of the marine environment in the United States.

B.1.2.2 Federal Occupational Safety and Health Administration

The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) is chartered to develop and promulgate occupational safety and a California agency is tasked with administering federal and the state's OSHA regulations. While occupational safety is not specifically public safety, it is mentioned here because attention to occupational safety will be a contributing factor to public safety. For example, OSHA regulations address crane operations, hazardous material handling, and safety analysis of hazardous operations. Regulation of these occupational hazard areas will additionally reduce potential for adverse impacts to public safety and the environment.

B.1.2.3 Long Beach Department of Health and Human Services

The Department of Health and Human Services is chartered to protect the public from exposure and/or the adverse health effects of hazardous substances. Hazardous substance requirements are also a matter of concern for the California Department of Toxic Substances Control, the Long Beach Health Department, and the Long Beach Fire Department.

Table B.1.2-1. Receipt, Storage, and Transfer Spacecraft and Upper Stage Fuel

Description, Hazard, Area of Concern	U.S. and International Agencies	State of California Agencies	Local Agencies

Public Safety	49 CFR, Transportation including: 171, General 177, Explosives 178, Packaging 32 CFR 650, Storage of Hazardous Materials 40 CFR 112, Oil Pollution 40 CFR 300-350, SARA	California Dept. of Toxic Substances Control, California State Office of Emergency Services	Long Beach Fire Dept., Risk Management and Prevention Program, Port of Long Beach, Tariff #4, Item 744, Rule on Dangerous and Hazardous Materials
Personnel Safety	29 CFR, Subtitle B, Chapter XVII, Occupational Safety and Health Administration, Section 119, Process safety management of highly hazardous chemicals	California Health and Safety Code, California Labor Code/ calico California Department of Health Services	
Equipment Safety	National Fire Protection Association 30, Chapter 4, Flammable and Combustible Liquids Code		City of Long Beach Dept. of Planning & Building
Environmental Protection	40 CFR, Protection of Environment, Environmental Protection Agency	California Environmental Protection Agency, California State Water Resource Control Board, Cal. Coastal Commission	Port of Long Beach, South Coast Air Quality Management District, Regional Water Quality Control Board

B.1.2.4 California Office of Emergency Management

The Office of Emergency Management is chartered to prevent or mitigate damage to human health and the environment. This requirement is promulgated through the Business Emergency Plan, which is submitted to and evaluated by the Long Beach Fire Department.

B.1.2.5 Long Beach Fire Department

The Long Beach Fire Department is responsible for the protection of life and property within the community. One of the major permits that Sea Launch must obtain is the Risk Management and Prevention Plan (RMPP). The RMPP includes an intensive system safety evaluation of the design of equipment, work practices, system reliability, and preventive maintenance procedures. It also includes risk assessment for specific equipment, emergency response planning, and the internal or external auditing procedures.

Table B.1.2-2. Transfer of LOX, Kerosene, Nitrogen, and Helium from Transport Trucks to LP Storage Tanks

Description, Hazard, Area of Concern	U.S. and International Agencies	State of California Agencies	Local Agencies
Public Safety	49 CFR, Transportation	California Dept. of Toxic Substances Control, California State Office of Emergency Services, California Harbor and Marina Code	Long Beach Fire Dept., Port of Long Beach, Tariff #4, Item 744, Rule on Dangerous and Hazardous Materials
Personnel Safety	29 CFR, Subtitle B, Chapter XVII, Occupational Safety and Health Administration	California Health and Safety Code, California Labor Code/ Calico, California Department of Health Services	
Equipment Safety	National Fire Protection Association 30, Chapter 4, Flammable and Combustible Liquids Code 49 CFR, Transportation	California Harbor and Marina Code	City of Long Beach Dept. of Planning & Building
Environmental Protection	40 CFR, Protection of Environment, Environmental Protection Agency	California Environmental Protection Agency, South Coast Air Quality Management District, California State Water Resource Control Board, Cal. Coastal Commission	Port of Long Beach, Regional Water Quality Control Board

Table B.1.2-3. Receipt, Storage, and Transfer to ACS of Solid Rocket Motors and Ordnance

Description, Hazard, Area of Concern	U.S. and International Agencies	State of California Agencies	Local Agencies
Public Safety	27 CFR, Chapter 1, Part 55, Bureau of Alcohol, Tobacco, and Firearms, Commerce in Explosives 29 CFR, Subtitle B, Chapter XVII, Occupational Safety and Health Administration, Section 109 Explosives	California Health and Safety Code, Division 11	Long Beach Fire Dept. Port of Long Beach, Tariff #4, Item 744, Rule on Dangerous and Hazardous Materials
Personnel Safety	29 CFR, Subtitle B, Chapter XVII, Occupational Safety and Health Administration, Section 109 Explosives	California Health and Safety Code, California Labor Code/ Calico	Long Beach Fire Dept.
Equipment Safety	National Fire Protection Association 495, Explosive Materials Code, Chapter 6, Above Ground Storage of Explosive Materials		Long Beach Fire Dept. Port of Long Beach, Tariff #4, Item 744, Rule on Dangerous and Hazardous Materials
Environmental Protection		No Impact (unless fire or other event releases chemicals to the environment (see 40 CFR)	

B.2 LAUNCH LOCATION ASSESSMENT

B.2.1 Preliminary Hazard Assessment of Pre-Launch Operations

Pre-launch operations will take place at the launch location and involve positioning the vessels, doing final processing of launch vehicle and satellite hardware, and staging and preparing equipment on the vessels to enable the launch. These operations are described in paragraph 5.2.1 as part of the assessment of environmental impacts. Employee safety considerations are addressed in the Safety Risk Assessment which is part of the Sea Launch license application (SLLP Launch License Application D688-10121-1). The Safety Risk Assessment includes provisions for readiness reviews and rehearsals prior to each launch to demonstrate that the Sea Launch personnel, policies, and procedures meet or exceed all safety standards and requirements imposed by AST.

B.2.2 Preliminary Hazard Assessment of Launch/Flight Operations

Flight operations for Sea Launch will begin with the liftoff of the launch vehicle from the launch platform and continue until the spacecraft is separated and the Block DM-SL is placed in a safe disposal orbit. For a typical GTO mission, the total elapsed time until spacecraft separation is approximately 50 minutes, of which nearly 20 minutes is in a thrusting state. Upon reaching LEO, approximately 13 minutes after liftoff, the potential for hazards affecting the earth are significantly reduced. Potential hazards resulting from flight operations can be grouped into two primary categories: normal operations and contingent operations. In each of these categories, hazards can also classified into two subsets: public safety and on-orbit safety.

B.2.2.1 Normal Operations

B.2.2.1.1 Public Safety

During normal flight of the launch vehicle, all operations prior to attainment of LEO occur over open ocean waters. An important parameter used to quantify hazard potential is the instantaneous impact point (IIP). The IIP is the location on the earth's surface where the launch vehicle would impact if the thrust were terminated. The IIP can be used to predict areas in which pieces of the rocket will impact the earth's surface at various times in the ascent trajectory. Additional effects, such as launch vehicle dispersions, atmospheric drag and winds, can also be applied to the IIP to give higher confidence to the regions in which returning debris is likely to fall. Because of the remote launch location, all pieces of debris normally returning to earth fall in open ocean waters.

Figure B.2.2-1 shows the ascent groundtrack and IIP as functions of time for a typical GTO mission. During staging operations prior to the attainment of LEO, the spent stages are jettisoned and return to earth under gravitational influence. Additionally, shortly after Stage 2 ignition, the protective fairing surrounding the spacecraft is also jettisoned for return to earth. A sleeve adapter surrounding the lower portions of the Block DM-SL is also jettisoned during Stage 2 separation. As shown in the figure, all pieces of debris return to earth over broad ocean waters. Shipping traffic routes indicate that the vessel density in the equatorial debris fall zones is among the lowest in the world. Since no debris impacts on populated areas, the risk to public safety from normal operations is negligible.

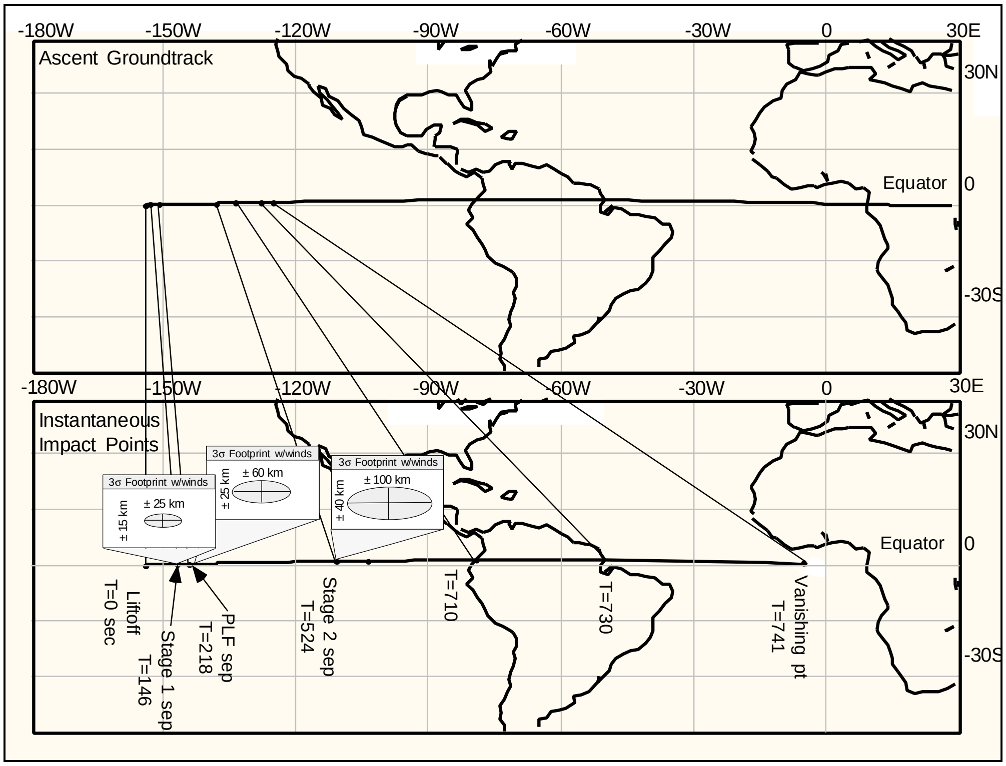

Figure B.2.2-1. Typical Ascent and Instantaneous Impact Point Groundtrack

B.2.2.1.2 On-Orbit Safety

After the vehicle reaches LEO, the primary hazards associated with the flight operations are related to the generation of orbital debris. This is most important during separation and after mission completion when the spent Block DM-SL is left in a disposal orbit. During separation, there is the potential for the generation of orbital debris from pyrotechnic bolts or releasing mechanisms. Sea Launch requires that no orbital debris be generated during spacecraft separation, thus mitigating the hazard risk of orbital debris generation from separation bolts or debris. For long-term storage of spent upper stages, Sea Launch has adopted NASA 1740.XX ("Guidance and Assessment Procedures for Limiting Orbital Debris," 1995) as a program goal for mitigating the risk of on-orbit debris. This NASA document defines characteristics for both normal and contingent operations. One of the critical parameters for normal operations is the spent upper stage final disposal orbit. Figure B.2.2-2 shows the acceptable regions for circular disposal orbits. For transfer orbits, the projected life until atmospheric reentry should not exceed 25 years. Shortly after successful spacecraft separation, the Block DM-SL vents all propellants and gases. This procedure mitigates potential problems associated with previous Block DM ullage motor tanks exploding while in the post-mission storage orbit and provides for a safe storage configuration.

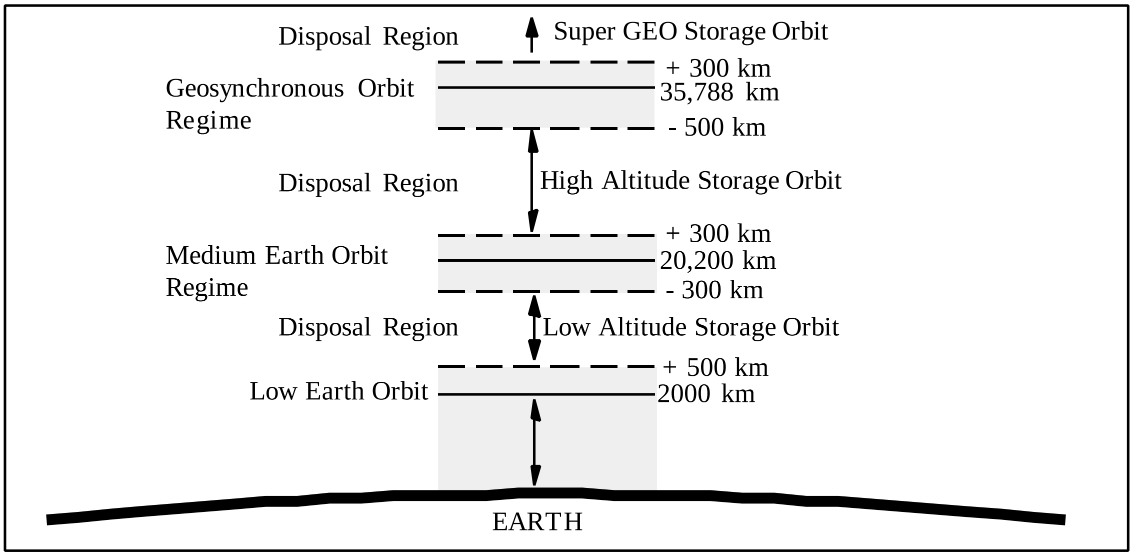

Figure B.2.2-2. Circular Disposal Orbit Regimes for Spent Stages

B.2.2.2 Contingent Operations

B.2.2.2.1 Public Safety

Contingent operations include the various failure modes that cause the vehicle to operate in an unsafe or unplanned trajectory. Such operations include, but are not limited to, rocket motor failures, explosions, control system failures, and electronic system failures. Since the launch occurs in remote ocean waters, the vast majority of the IIP dwell time is spent over ocean waters. Because of this fact, the flight hazards that potentially affect the general public are reduced. In order to assess the hazard risk during IIP passage over populated areas of South America, a quantifiable measure of risk must be used. One such measure of safety commonly used is the casualty expectation, which is the probability of a fatality due to flight operations. A typical level of safety for rocket launches is one casualty for each one million launches. This casualty value has been adopted as the Sea Launch objective for overall flight safety based on its functional equivalence to the values used at U.S. Government launch ranges. A comparison between Sea Launch and traditional functions performed by the U.S. at the Eastern Test Range (Cape Canaveral) and the Western Test Range (Vandenberg) was considered (SSLP, 1997).

Sea Launch safety assurance will be primarily obtained through proper analysis, testing, mission planning, and design of the Zenit flight safety system, and is described fully in the Sea Launch System Safety Plan. Determination of the casualty expectation is a function of the system failure rate, impact debris size, population density, and the time the IIP remains over populated areas (i.e., dwell time). For a typical GTO mission, the casualty expectation is considerably less than the one in a million safety objective (SSLP, 1997).

To ensure safe launch vehicle operations in the event of a flight contingency, the Zenit-3SL will incorporate an autonomous flight safety system (FSS) that reduces the hazard risk presented to the public. The FSS will use the Zenit-3SL flight control computers to monitor both computer health and status and mission performance. In the event of a failure in the computer or in the overall launch system, a thrust termination system will be activated that terminates engine thrust. In order to assess the flight computer health and status, three processors will be used in a voting scheme to filter out anomalous signals or failed processors. If the computer determines it is operating without sufficient redundancy, it will issue a command to terminate the launch vehicle thrust. Flight performance verification will be accomplished by comparing the actual launch vehicle flight angles with preplanned flight angles. Whenever the actual angles exceed predetermined tolerance limits, the flight computer will terminate main engine thrust, preventing errant rocket trajectories. Figure B.2.2-3 illustrates these angles for a typical GTO mission. By conducting computer simulations of a wide variety of failures at various times in the ascent trajectory, impact limit lines (ILL) can be determined for the purposes of determining where debris could fall. A statistical confidence level, such as three standard deviations, is commonly used to quantify the dispersions that could cause the debris to fall within this flight corridor if a catastrophic failure were to occur. The ILLs include dispersions in launch vehicle guidance, navigation and control systems, as well as atmospheric wind effects.

Through the combination of a remote launch location and the autonomous FSS, hazards to the public will be minimized and kept well within acceptable levels.

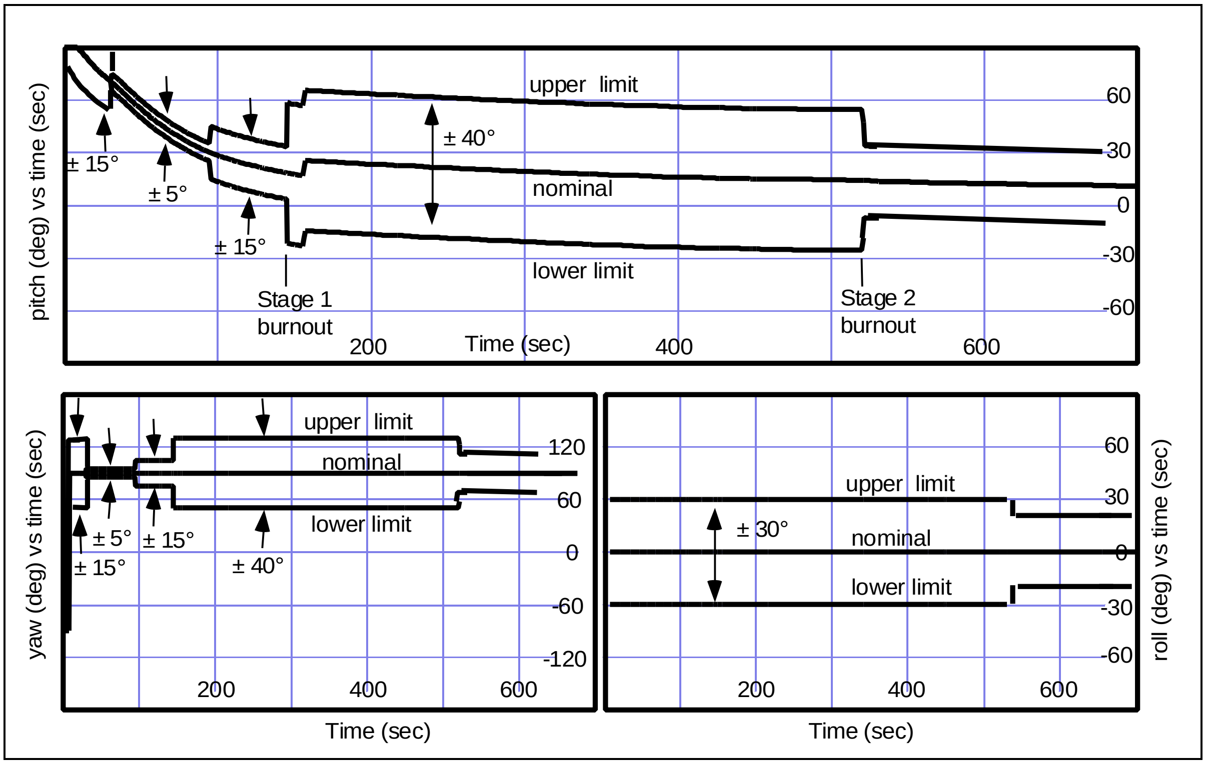

Figure B.2.2-3. Flight Safety Angle Limits

B.2.2.2.2 On-Orbit Safety

Once in orbit, potential hazards to other spacecraft will occur if a flight contingency occurs. As discussed in Section 5, paragraph 5.2.4, contingent flight operations will result in two primary failure modes. The first is when an in-flight fire or explosion destroys the Block DM-SL and spacecraft, dispersing fragments in orbit. This failure mode is more hazardous for on-orbit safety, since a potentially large number of pieces propagate through space, creating the potential for orbital collisions with viable spacecraft. In the second failure mode, the FSS system terminates thrust and separates the spacecraft prior to its intended orbit. This failure mode is desirable because the Block DM-SL vents all gasses and propellants and remains intact in orbit. Additionally, the spacecraft is also separated, thus providing for potential mission salvage through the spacecraft onboard systems.

B.2.3 Preliminary Hazard Assessment of Post-Launch Operations

Operations data for this section are very preliminary; more detailed information will be available in 1997 and may be requested from SLLP at that time.

B.3 CHARACTERISTICS OF HAZARDOUS MATERIAL

The principal hazardous material handled at Sea Launch facilities are the chemicals used in the propulsion systems of the integrated launch vehicle. These include liquids, solids, and ordnance used to operate propulsion system valves, to operate each stage of the rocket, and to operate the spacecraft (see Table B.3-1 for a listing of ILV hazardous materials). Ordnance is also used to initiate spacecraft appendage deployment after launch.

Table B.3-1. Summary of Integrated Launch Vehicle Hazardous Material

Rocket Vehicle	Approximate Mass
1. Propellant mass loaded on Stage 1:	325,100 kg
a. Liquid oxygen	235,330 kg
b. RP-1 fuel	89,775 kg
c. Starting fuel	4.25 kg
2. Propellant mass loaded on Stage 2:	81,650 kg
a. Liquid oxygen	58,700 kg
b. RP-1 fuel	22,950 kg
c. Starting fuel	4.25 kg
3. Upper stage, Block DM-SL:	
a. Main propellant mass loaded	14,870 kg
b. Liquid oxygen	10,545 kg
c. RP-1 fuel	4,325 kg
d. Propellant mass loaded in the auxiliary propulsion system & main engine starting fuel	
(1) Nitrogen tetroxide	35 kg
(2) Monomethylhydrazine	60 kg
(3) Nitrogen (pressurization)	2 kg
(4) Starting fuel (mixture of triethylaluminum and trimethylaluminium)	2 kg
Data On Pyrotechnics	**Quantity of Hardware**
1. Stage 1:	
a. Solid rocket retromotors (21.1 kg propellant each) within the separation system	4
b. Pyrotechnic valve in the propellant system	1
c. Pyrotechnic valves in the pressurization system (helium supply from submerged high pressure vessels)	5
2. Stage 2:	
a. Solid rocket retromotors (5.25 kg propellant mass each) in the stage separation system	4
b. Explosive bolts for separation from Stage 1	10
3. Upper stage (Block DM-SL):	
a. Explosive bolts for separation from Stage 2	10
b. Explosive bolts for sleeve separation	8

Liquid fuels and oxidizers will be used as propellants. The spacecraft will be primarily fueled with MMH; however, some spacecraft will use anhydrous hydrazine (AH). The oxidizer used by the spacecraft is primarily N_2O_4. These components are handled at ambient conditions without elevated pressures or reduced temperatures. They are volatile and, when in contact with one another, will spontaneously ignite, liberating extremely large quantities of heat and gas (hypergolic). A particular spacecraft may require only fuel (i.e., monopropellant system) or both fuel and oxidizer (i.e., bipropellant system).

The upper stage (Block DM-SL) attitude control/ullage propulsion engines use MMH and N_2O_4. The two stages of the Zenit and the main engine of the upper stage use kerosene (RP-1) for fuel and liquid oxygen as the oxidizer. The upper stage fuel is loaded prior to mating with the Zenit second stage. The remaining fuel and oxidizer are loaded during pre-launch processing at the launch location after personnel have evacuated the launch platform.

The following quantity of material represents the maximum expected for any launch:

1. Spacecraft propellant for a typical spacecraft.

a)	MMH	680 kg (1,500 lb)
b)	N_2O_4	1,043 kg (2,300 lb)

2. Upper stage (Block DM). To provide backup, the total quantity on location may be twice this amount.

a)	MMH	35 kg
b)	N_2O_4	60 kg

Note: The propellant quantities listed in Section 4, table 4.2.2-1, may be different because they are mission specific.

The major hazard from these propellants result from the flammability and reactivity characteristics. These propellants have properties similar to other hazardous chemicals, which are routinely transported throughout the U.S. on the nation’s highways, and are manufactured and used in a variety of industrial operations. Hydrazine is a key ingredient in a variety of agrochemicals, including many common pesticides, fungicides, algaecides, bactericides, and herbicides.

Hydrazines are volatile chemicals that react readily with carbon dioxide and oxygen in the air and will also decompose some metals on contact. Hydrazine is slightly less dense than water; the vapors are more dense than air. If hydrazine vapor is released into the air in sufficient concentrations, it may ignite or react to form ammonia and oxides of nitrogen. Further oxidation will form ammonia-based nutrients and will ultimately return to earth as nitric acid rains.

Hydazines are also corrosive, poisonous, and can present serious health hazards upon direct contact with sufficient quantities of either the liquid or vapor. The most severe exposures occur through dermal (i.e., skin) contact with liquid and inhalation. Contact of the chemical on the skin can cause severe burns and can enter the bloodstream, leading to similar effects caused by inhalation. These effects may include damage to the central nervous system which can result in tremors, convulsions, or death in the case of extremely high concentrations of the chemical. According to the American Council of Industrial and Government Hygienists, hydrazine is also a suspected human carcinogen.

Nitrogen tetroxide is a thick, heavy, and very volatile liquid. Its vapor pressure is about 50 times that of water and about five times that of acetone. Though not flammable itself, N_2O_4 enhances the combustion of most fuel sources and may ignite organic materials. Nitrogen tetroxide reacts with water in a vigorous reaction that produces nitric and nitrous acids and NO_2. Contact with corrosive N_2O_4 liquid or vapor may lead to burns of the skin and eyes. Inhalation of a sufficient quantity of N_2O_4 vapor causes adverse health effects and may initially occur without great discomfort. A few hours later, however, more severe symptoms of tightness in the chest, coughing, and breathing difficulty may begin and could result in pulmonary edema, and in severe cases, death.

The principal environmental and personnel protection method employed is through system design. A principle of zero planned release of hydrazine into the environment has been incorporated in the design of the systems and development of procedures used for their processing. The potential for accidental release has been assessed and appropriate containment for the operating area and scrubber systems is being incorporated into the facilities design.

Procedures have been written that will help safeguard and instruct the operating personnel. These procedures define proper sequencing of critical events, provide detailed instruction where required, define use of personnel protection equipment, define the establishment of controlled areas, and define the limitation of access to essential personnel in potentially hazardous operating areas.

Waste containment and neutralization systems serve the fuel and oxidizer propellant operating areas. All propellant vapors released in processing areas will be processed through these systems. Tanks collect any liquid spillage which could occur during propellant transfer operations.

The greatest hazard during operations with these components is the potential of mixing hypergolic materials. The principal defense for this potential hazard is to separate components. Separate storage areas and processing systems have been incorporated into the design of both the PPF and the ACS. The principal operational control is in processing one component at a time and in complete cleanup following that operation prior to starting the next operation.

The potential for an explosive environment developing in the hydrazine processing area has been considered and the design requirements for these areas have been incorporated. The PPF is designed per the National Electric Code, Section 70, of the National Fire Protection Association Codes. The ACS Block DM-SL fueling compartment is designed per Det Norske Veritas, Rules for Classification of Ships. Static grounds are provided for fueling equipment, and adherence to written procedures will ensure proper connection during operations.

The danger of a tank leaking toxic material during handling is mitigated by compliance to 49 CFR, Transportation. DOT approved tanks for hypergolic fuels and oxidizers are used for transportation, temporary storage of spacecraft, and upper stage hazardous fuel components.

Exhaust gas composition for N_2O_4 and N_2H_4[1] is as follows:

1. CO 0.03561
2. CO_2 0.09563

[1] AIAA Workshop Report dated 1 October 1991, Atmospheric Effects of Chemical Rocket Propulsion, Table 8.

3. H 0.00006
4. H_2 0.04969
5. H_2O 0.45886
6. OH_x 0.00003
7. N_2 0.36012

The primary hazard from solid propellant in the SRMs processed in Sea Launch facilities is due to its flammability. Solid propellant is classified by the DOD as a Class 2, Division 1.3 (non-mass - detonation, mass-fire hazard). (Reference DOD Directive 6055.9, DOD Ammunition and Explosives Safety Standard, July 1984). The material itself is not explosive; however, a solid propellant produces large volumes of gas when burning, which can result in the rupture or propulsion of the case.

The solid propellant used in the Zenit separation motors is a nitrocellulose base with less than 10% nitrogen. This chemical composition relates to a hazard class of flammable solid, DOT Class 1.4. Because the packaging of the chemical is in a motor case, it is considered a DOT Class 1.3.

1. Zenit first stage: four solid rocket retromotors (21.1 kg propellant each) within the separation system.
2. Zenit second stage: four solid rocket retromotors (5.25 kg propellant mass each) in the stage separation system.

Exhaust gas composition for the SRM exhaust plume is as follows:

1. CO 0.3858
2. H_2O 0.1411
3. H_2 0.2045
4. N_2 0.1171
5. CO_2 0.1506
6. Pb 0.0009

Liquid oxygen is not an environmental hazard. The volume of liquid oxygen required to support a launch cycle is 500 metric tonnes.

The significant hazards related to operations involving liquid oxygen are:

1. Oxygen enriched atmosphere supports accelerated combustion of fuels.
2. Extreme low temperature. The systems used to handle cryogens will be designed and operated in accordance with industry standards.

The combination of kerosene and liquid oxygen has been used as a propellant system in launch vehicles by most countries since space programs started. This use of liquid oxygen/kerosene has resulted in high vehicle reliability, an excellent safety record, and efficient launch operations. Its good performance and high density is well suited for the minimum-size launch vehicle. The ease of handling and ambient storage temperatures of kerosene make it suitable for a shipboard-based launch system. Safety requirements for handling kerosene onboard a ship are similar to those of handling diesel fuel.

The emissions from liquid oxygen and kerosene have minimal effect on the environment. Exhaust product composition for LOX and kerosene are:

1. CO 0.35954
2. CO_2 0.14479
3. H_2 0.26265
4. H_2O 0.23301

As the exhaust is discharged into the atmosphere, afterburning will occur, modifying the mole fractions and introducing some new compounds (i.e., NO_x) which are eventually released in the atmosphere. Quantitative data on the products generated by afterburning as a function of altitude are not available.

Nitrogen is not a hazardous substance and will not, under normal conditions, pose a threat to the public. For each launch cycle, 240 metric tonnes of liquid nitrogen is loaded onboard the LP and 10 metric tonnes of gaseous nitrogen is loaded on the ACS.

It may be a public hazard under the following conditions:

1. Release of nitrogen gas in an enclosed space may result in an oxygen deficient environment that will not support life. This condition is addressed in the design of the ACS and LP. Oxygen monitors have been included in spaces that could potentially contain an oxygen deficient atmosphere.
2. Operating procedures and instructions will include provisions to ensure access control of confined spaces as required by existing regulations.
3. The extreme low temperature of liquid nitrogen is a hazard. The systems used to handle cryogens will be designed and operated in accordance with industry standards.

Helium gas is not a hazardous substance and will not, under normal conditions, pose a threat to the public. It may be a public hazard when a large volume is released in an enclosed or confined space resulting in an oxygen deficient environment. The approximate amount of gaseous helium loaded on the LP (at 400 kgf/cm^2 pressure) in support of each launch cycle is 0.9 metric tonnes; the ACS is 0.5 metric tonnes.

Ordnance devices employed are defined as electroexplosive devices, detonators, squibs, primer, pyrotechnic devices, solid rocket motors, and energy transfer systems. The hazards produced by ordnance are the potential for ignition or detonation.

Ordnance items being transported to Sea Launch facilities from within the U.S. will be examined in accordance with CFR 49, Part 173.56, by the Association of American Railroads, Bureau of Explosives or U.S. Department of Interior, Bureau of Mines, and assigned a recommended shipping description and hazard classification. Ordnance items will be approved for transportation by the U.S. Department of Transportation. For ordnance items originating outside of the U.S., the Associate Administrator for Hazardous Materials Safety acceptance of an approval, issued by the competent authority of the country of origin as listed by the International Maritime Dangerous Goods (IMDG) Code, will be required.

Written acknowledgment of acceptance must be received before shipment. Copies of the acknowledgment and of the competent authority approval must accompany each shipment.

Both the ACS and LP are built in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) to control the discharge of oil into the environment. There is no greater risk to the environment from Sea Launch vessels than from any other ship. The following is the estimated usage of fuels for each round trip between the Home Port and proposed launch location:

1.	Diesel oil	ACS	1,350 m^3
		LP	1,450 m^3
2.	Lube oil	ACS	6 m^3
		LP	8 m^3

Helium gas is not a hazardous substance and will not, under normal conditions, pose a threat to the public. It may be a public hazard when a large volume is released in an enclosed or confined space resulting in an oxygen deficient environment. The approximate amount of gaseous helium loaded on the LP (at 400 kgf/cm^2 pressure) in support of each launch cycle is 0.9 metric tonnes; the ACS is 0.5 metric tonnes.

B.4 HAZARDOUS WASTE

The N_2H_4 and N_2O_4 processing system design will minimize the generation of hazardous waste. Excess N_2H_4 and N_2O_4 remaining after an operation will be returned to the manufacturer for recycling. Spillage of any N_2H_4 and N_2O_4 will be neutralized in the collection tanks and properly disposed of. Other hazardous materials used during launch vehicle assembly, conducted at the Home Port and onboard ships, will generate a minimum amount of waste. The materials used include paints, cleaning agents/solvents, and various adhesives. The following is a generic list of typical items:

1. acetone
2. ethyl alcohol
3. gasoline
4. isopropyl alcohol
5. lacquers
6. polyamide resins
7. lubricants

Disposal of all hazardous wastes will be accomplished in accordance with all international, Federal, state and local requirements of the Home Port.

B.5 GENERAL INDUSTRIAL WASTE

B.5.1 Home Port Facility Non-Hazardous Waste

The Home Port is expected to generate a relatively limited amount of nonhazardous waste similar in quantity to that required to support the maintenance and operations of a small office complex. Nonhazardous waste will be removed from the site by a locally contracted waste management company. Site wastes will be managed according to their source and characteristics and options for recycling and reuse. Plans coordinated with local officials as noted will address as appropriate the separation of hazardous from nonhazardous wastes, waste collection, training and instructions for employees, and planning for process changes and their associated wastes.

B.5.2 Shipboard Waste

Approximately 100 liters of diesel or kerosene is used per month onboard each vessel for general cleaning of machinery. Approximately four liters of Electro-clean (white spirit) is used per month onboard each vessel for general cleaning of electrical equipment.

Waste products onboard the ACS will be collected in containers and burned in the ship's incinerator during the voyage or transferred to the Home Port for disposal/recycling.

Bilge water is normally separated onboard each vessel during the voyage. However, arrangements have to be provided for transferring the bilge water ashore during long stays in the Home Port. The ACS is provided with a bilge water tank of 160 m^3, and the LP has a tank of 30 m^3.

Sewage/gray water will be discharged to publicly-owned treatment works via the Home Port shore facilities while in port. During sea operations, the sewage treatment plant on the ACS and LP will handle sewage/gray water in compliance with Annex IV, Regulations for the Prevention of Pollution by Sewage of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78).

Oil sludge will be separated onboard each vessel. Onboard the ACS, waste oil products will be burned in the ship's incinerator during the voyage. In port, shore connections for delivery of oil sludge will be provided for each ship.

Garbage will be handled during the voyage in accordance with Annex V, Regulations for the Prevention of Pollution by Garbage of MARPOL 73/78. Garbage suitable for burning will be burned in the ACS incinerator during the voyage. Other garbage onboard the ACS and all garbage onboard the LP will be collected in containers and transferred ashore when in port.

B.6 LIST OF HAZARDOUS MATERIALS

Table B.6-1 provides a listing of hazardous materials identified to date. Any hazardous waste generated during spacecraft and launch vehicle processing will be controlled in accordance with EPA hazardous waste regulations and transported in accordance with DOT regulations. The table contains a preliminary listing of hazardous material and the approximate quantity used during processing of each launch vehicle. Data on the documents listed for reference have been provided by the Sea Launch Limited Partnership.

Table B.6-1. List of Typical Hazardous Materials

Material	Approximate Quantity Used Per Launch	References, Remarks
Acetone	1.5 L (B-DM) 0.5 kg (Zenit)	GOST 260-79
Adhesives (various)	1.22 kg (B-DM)	
Diethyleneglycolurethane	0.02 kg (B-DM)	
Ethyl alcohol	6.0 L (B-DM) 20 kg (Zenit)	GOST 5962-67 Highly flammable fluid. Rate 3
Gasoline	2.0 L (B-DM)	Highly flammable fluid. Rate 3
Isopropyl alcohol	TBD	Highly flammable fluid. Rate 3
Lacquer	0.5 kg (B-DM)	Highly flammable fluid. Rate 3
Lubricants	0.6 kg (B-DM)	Highly flammable fluid. Rate 3

Material	Approximate Quantity Used Per Launch	References, Remarks
Methyl ethyl ketone	TBD	Highly flammable fluid. Rate 3
Paints	2 kg (B-DM)	Highly flammable fluid. Rate 3
White spirit	1 kg (Zenit)	GOST 313-18. Highly flammable fluid. Rate 3
Cold carrier "Chladon-113"	30 kg (Zenit)	GOST 23844-79. Non-flammable, low toxic fluid. Rate of hazard defined by PEL in working zone per GOST 12.1.007-79. Rate 4 (PC 3000 mg/m)
Nefras-S3-80/120	1 kg (Zenit)	GOST 443-76. Highly flammable fluid. Rate 3
Working fluid "L3-MG-2"	14 kg (Zenit)	TY-38.10128-81 Highly flammable fluid. Rate 3
Hermetic paste "VGO-1"	4 kg (Zenit)	TY 38.303-04-04-08 GOST 12.1.004-85 Group IV Flammable product.
Hermetic paste "YG-5M2"	4 kg (Zenit)	TY-6-01-2-670-88 Highly flammable fluid. Rate 3
Glue "BF-4"	0.1 kg (Zenit)	GOST 12172-74 Highly flammable fluid. Rate 3
Glue "88-CA"	0.5 kg (Zenit)	TY 38-105760-87 Highly flammable fluid. Rate 3
Glue "88-NP"	0.5 kg (Zenit)	TU 38.105540-73 Highly flammable fluid. Rate 3
Glue NT-150	0.5 kg (Zenit)	TY-38.105789-75 Highly flammable fluid. Rate 3
Glue "VK-9" consisting of: a. Resin "ED-20" b. Resin "PO-300" c. Product "AMG-3" d. Product "ADZ-3" e. Titanium dioxide	(Zenit) 0.3 kg 0.2 kg 0.0029 kg 0.001 kg 0.025 kg	GOST 92-0949-74. GOST 10587-84, Moderately dangerous substance Rate 9 TY 6-10-1108-76 Highly flammable fluid. Rate 3 Highly flammable fluid. Rate 3 Fire & explosive safe material. Rate of hazard defined by PC in working zone per GOST 12.1.007-79. Rate 4 (PC 3000 gm/m)
Glue "K-300-61" consisting of: a. Resin "SEDM-6" b. Polyamide resin "L-020" c. Titanium dioxide	(Zenit) 0.6 kg 0.24 kg 0.18 kg	GOST 92-0949-74 GOST 6-05-5125-82, Fire & explosive safe material. TY 6-05-1123-73, Fire & explosive safe material. Fire & explosive safe material. Rate of hazard defined by PC in working zone per GOST 12.1.007-79. Rate 4 (PC 3000 gm/m)
Nitroglue	0.2 kg (Zenit)	TY 6-10-1293-78, Highly flammable fluid. Rate 3

Notes:

1. This list provides an indication of the launch process potential impact. Industrial materials used to operate and maintain the vessels and maintain the Home Port facilities have not been identified.
2. The launch operations supported by the vessels and Home Port facilities includes the assembly of manufactured components, but does not include manufacturing processes that use hazardous chemicals or metals.

C. PROJECT ORGANIZATION AND PARTNER RESPONSIBILITIES

The entity responsible for environmental concerns on the Sea Launch Program is the SLLP acting through its General Partner, the Sea Launch Limited Duration Company. Both the SLLP and the Sea Launch LDC are organized under the laws of the Cayman Islands, B.W. I. The SLLP is responsible for the development work and for entering into launch contracts with customers and performing those contracts. The address and telephone number of the SLLP, the Sea Launch Limited Duration Company, and the Launch Platform Limited Partnership are:

Sea Launch Company, LDC
Windward I, Safehaven Corporate Centre West Bay Road
P.O. box 10168 APO
Grand Cayman, Cayman Islands British West Indies

phone: 1-345-945-8390

fax : 1-345-945-8388

There are four companies involved in this venture:

1. Boeing Commercial Space Company
2. Kværner Maritime a.s
3. KB Yuzhnoye
4. RSC Energia

The Limited Duration Company is the General Partner of the SLLP and will perform under The Company Law (Revised) of the Cayman Islands. The Limited Duration Company will issue contracts with the Partners for the development work on behalf of the SLLP.

The principal responsibilities of each company are illustrated in Figure C-1. A short description of each company's responsibility follows this introductory section.

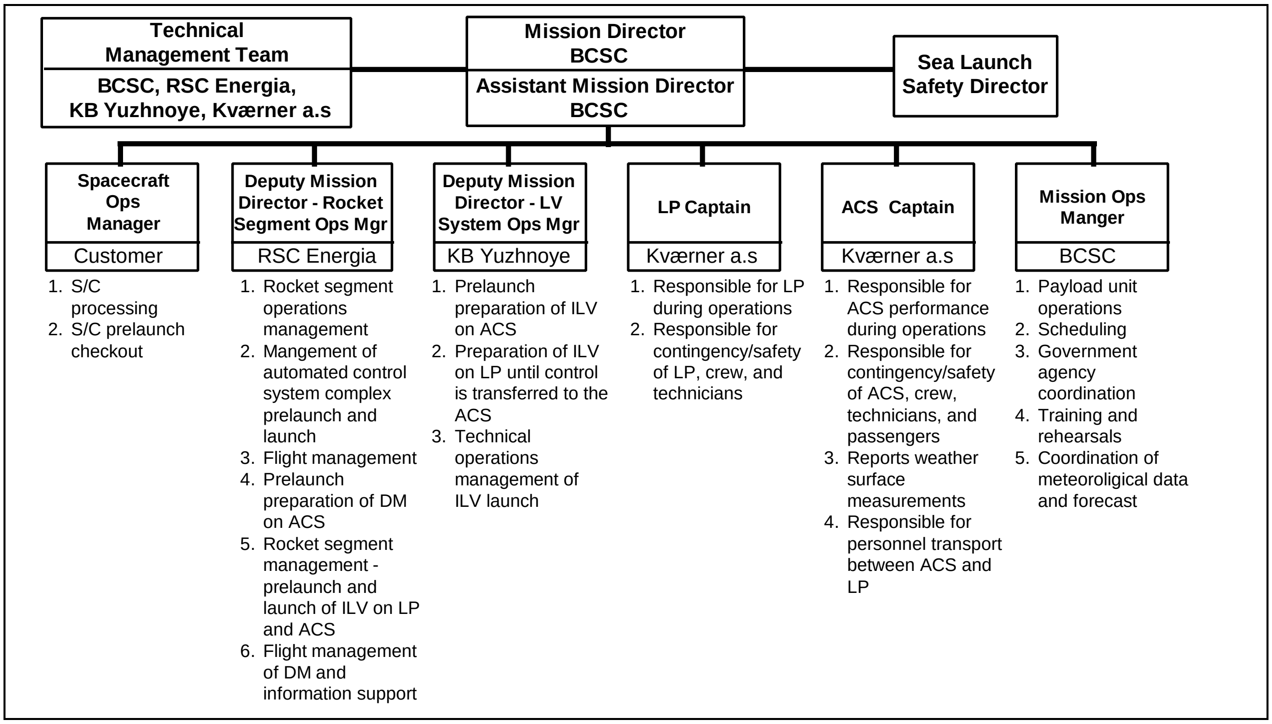

Figure C-1. Mission Operations Team

All launches will be licensed by AST FAA. Sea Launch is marketing its services to United States and international spacecraft manufacturers. The Sea Launch payloads will be communication, navigation, or remote sensing satellites. Payloads will be licensed by appropriate U.S. agencies and/or foreign countries. Registration of space objects is required by United Nations, Article IV of 1975 Convention on Registration of Objects Launched into Outer Space. The process Sea Launch has established for payload registration begins 60 days before launch with notification to AST. Thirty days before launch, Sea Launch will notify U.S. Space Command (USSC), 1st Command and Control Squadron, Combat Analysis Code J30XY, of the initial orbit parameters, points of contact, launch vehicle description, launch vehicle size, and description of object(s) to be orbited. On launch day, USSC will be notified that the launch has occurred. Within 30 days of the launch, AST will be provided with the international designator, date and location of launch, orbital parameters, and general information of the space object(s). For U.S.-owned payloads, AST transfers this information to the State Department, which notifies the United Nations within five months. The process is not yet determined for non-U.S.-owned payloads.

C.1 BOEING COMMERCIAL SPACE COMPANY

BCSC has the responsibility for project management, will submit the launch license application data package to AST, and will plan the missions and interface with the customer and/or spacecraft manufacturer. In addition, BCSC will develop and manufacture the PLF, the payload adapter (PLA), and will develop the Home Port. The development of the Home Port includes environmental analysis sufficient to satisfy all government jurisdictions (i.e., California governmental agencies, the City of Long Beach, the Port of Long Beach, local fire departments, and the U.S. Coast Guard). Also, BCSC will operate the Home Port and market the Sea Launch Venture. During the operational phase, BCSC will lead the Mission Operations Team.

C.2 KVÆRNER MARITIME A.S

Kværner Maritime a.s is constructing the ACS, refurbishing the LP, and will manage all maritime activities including all environmental analysis for maritime activities. During operational phase, Kværner will contract to operate the ACS and the LP.

The ACS Limited Partnership has entered into a contract with Kværner for building the ACS and for providing the ship to the LDC. In addition, it is responsible for related maritime planning, licensing, and operations.

The LP Limited Partnership has entered into a contract with Kværner for building the LP, providing the vessel to the LDC, and providing planning, licensing, and operations related to the LP.

C.3 KB YUZHNOYE

KB Yuzhnoye will modify and manufacture the Zenit's first and second stage hardware and software in order to meet new requirements levied by Sea Launch customers. During the operational phase, Yuzhnoye will support launch activities associated with the Zenit and associated Zenit ground support equipment. In particular, Yuzhnoye will support the pre-launch preparation of the ILV on the ACS and the preparation of the ILV on the LP until control is transferred to the ACS during the countdown phase.

C.4 RSC ENERGIA

RSC Energia is modifying and manufacturing the Block DM-SL upper stage hardware and software in order to meet new requirements levied by Sea Launch customers. In addition, Energia will install all launch vehicle vessel support equipment. During the operational phase, Energia will support launch activities and in particular will:

1. Manage the rocket segment operations.
2. Manage the automated control system complex during pre-launch and launch.
3. Manage the flight segment.
4. Execute the pre-launch preparation of the Block DM-SL on the AC.
5. Manage the rocket segment pre-launch and launch activities onboard the LP and ACS.
6. Manage the information support function during the flight of the Block DM-SL.
7. Manage the range assets including the ground stations in Russia.

D.1 GLOSSARY

accretion	Gradual buildup of land or seafloor formed by magma rising to the surface along some tectonic plate boundaries.
anaerobic	Absence of oxygen.
annelids	Multi-segmented, worm-like animals.
ascent groundtrack	The projection, on the surface of the earth, of the launch vehicle flight path from liftoff until orbit insertion.
benthic	Pertaining to or found at or on the sediment-water interface of a large body of water.
biomass	The dry weight of living matter present in a species or ecosystem population for a given habitat area or volume.
boundary layer	The lowest portion of the atmosphere where the frictional effects of the earth's surface are substantial.
Coriolis force	Inertial momentum causing deflection of a moving object relative to the earth's surface; objects moving north and south of the equator are deflected to the right and left respectively.
demersal	Living at or near the bottom of the sea.
echinoderms	Demersal marine organisms with an internal skeleton and a system for flushing water through the body to permit movement, respiration, nourishment, and perception.
ecosystem	A conceptual view describing the interrelationships, including the flow of materials and energy, between living and non-living features of a natural community.
exclusive economic zone (EEZ)	An offshore boundary, usually set at 320 km, establishing a nation's economic sovereignty over the resources present within that perimeter.
food chain	Scheme for describing feeding relationships by trophic levels among the members of a biological community.
habitat	The physical environment in which a plant or animal lives.
instantaneous impact point	The point on the surface of the earth where an airborne mass would strike without atmospheric (e.g., wind) or continuing propulsive effects; the area containing impact points is described by impact limit lines.
ionosphere	That part of the earth's upper atmosphere which is ionized by solar

	ultraviolet radiation so that the concentration of free electrons affects the propagation of radio waves.
mass balance	The accounting of all energy and/or matter that is in flux between or stable within subdivisions of a physical process or ecosystem.
mesosphere	That part of the earth's atmosphere above the stratosphere characterized by a temperature that generally decreases with altitude.
ozone	A form of oxygen, O_3, naturally found in the ozonosphere within the stratosphere.
phytoplankton	Passively floating or weakly self-propelled aquatic plant life.
primary productivity	New organic matter produced by plant life.
stratosphere	That part of the earth's atmosphere between the troposphere and the mesosphere in which the temperature increases with altitude.
tectonics	Movement and deformation of the earth's surface caused by fluid circulation beneath the surface.
thermosphere	That part of the earth's atmosphere extending from the top of the mesosphere to outer space, including the exosphere and ionosphere, marked by more or less steadily increasing temperatures with altitude.
trophic level	A broad grouping of organisms within an ecosystem defined as being in the same tier in the food chain hierarchy; most generally, the first trophic level is the photosynthetic plants, the second is the herbivores, and the third is the carnivores.
troposphere	That part of the atmosphere extending from the earth's surface to an altitude of 10 to 20 km, in which the temperature generally decreases with altitude.
upwelling	The process by which water rises from a deeper to a shallower depth; may be caused by a variety of physical phenomena.
zooplankton	Passively floating or weakly self-propelled aquatic animal life.

D.2 UNIT CONVERSION TABLE

Length

1 km (kilometer)	=	0.621 mile
1 m (meter)	=	3.28 feet
1 cm (centimeter)	=	0.394 inch
1 mm (millimeter)	=	0.0394 inch
1 µm (micron)	=	0.0000394 inch

Mass

1 kg (kilogram)	=	2.20 pounds
1 g (gram)	=	0.0353 ounce
1 mg (milligram)	=	0.0000353 ounce

Energy

1 J (joule)	=	0.239 calories

Velocity

1 km/second	=	2,240 miles/h
1 m/second	=	2.24 miles/h

Force

1 N (Newton)	=	0.225 pound (force)
1 kgf (kilogram force)	=	2.205 pound (force)

Volume

1 L (liter)	=	0.26 gallon

Probability (example)

1 in 1 million	=	$1x10^{-6}$
Degree of Latitude	=	Each 15^{o} of latitude represents approximately 1,034 miles